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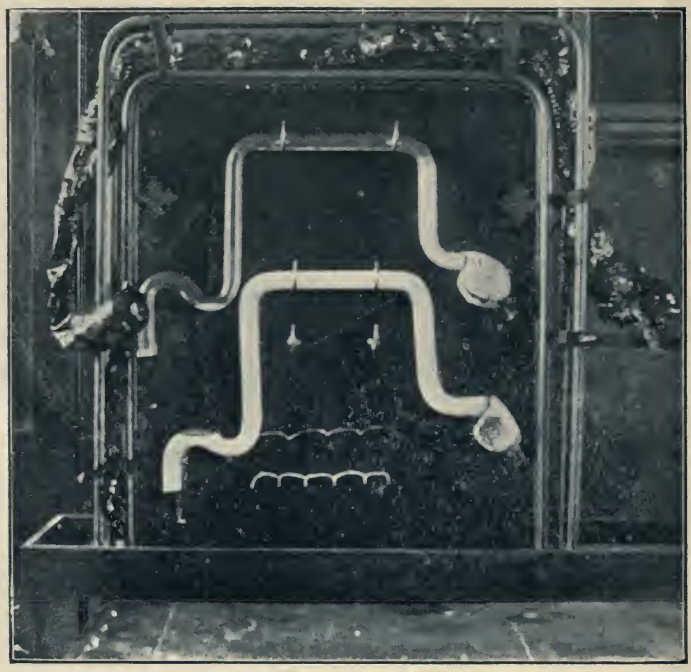
ON SYPHONAGE

AND HYDRAULIC PRESSURE

IN THE

LARGE INTESTINE



Syphon I. represents the rectum empty and the cæcum full.

Syphon II. represents the full rectum and the vacuum in the cæcum.

The white lines on the screen show the deepening of the saccular ridges produced by tonic contraction of the longitudinal bands.

The framework supports a dried large intestine.

ON SYPHONAGE AND HYDRAULIC PRESSURE IN THE LARGE INTESTINE

WITH THEIR BEARING UPON THE TREATMENT OF CONSTIPATION, APPENDICITIS, ETC.

BY

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PREFACE

THE author's attention has been specially drawn to the large intestine for some years; but the idea of a syphon only dates from last autumn. He contributed an article on this subject to the December number of the *Edinburgh Medical Journal* and, during the same month, this was published as a reprint together with some supplementary notes in which he sought to prove that the longitudinal bands are in a state of tonic contraction. This has been now confirmed by observation. The views given have excited wide-spread interest, and as the brochure is no longer procurable

the present work has been designed to take its place in a more ample manner.

In modern times but little attention has been given to the generalisation and co-ordination of observations bearing upon the science and practice of medicine; yet the want of such co-ordination is a serious menace to the future. Already there is so much to be learnt that the choice seems to lie between the necessarily imperfect knowledge of the man who takes the whole domain for his sphere of action and that of the specialist who, comparatively regardless of the inter-dependence of organs, confines his labours and his knowledge of advances to a part. The tendency of the future will be to divide and sub-divide these specialties, and the time will come when the possession of a grasp of the whole subject will be impossible. The arts

of general diagnosis and of prognosis will wane, and, the pendulum swinging back to empiricism, the quack will attain his apotheosis.

The only remedy for the increasingly crushing burden upon the memory is the cultivation of the Darwinian faculty of generalisation, and it is the author's hope that he has made a modest advance in this direction.

R. W. L.

32 Buckingham Gate, S.W.
May 1903

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MANY centuries have passed since the large intestine was described, and many thousands of anatomists have examined it closely. Amongst them, some must surely have marvelled that a mechanism so ill adapted for an erect being could do its work so well.

There is a key to the problem; but without the key nothing could well appear more faulty in design. If, for purposes of absorption, it was necessary to retard the stream and increase the surface by widening the bowel, why arrange its course so that a good part of its contents must be propelled against gravitation? Or if

its present course was indispensable, why not provide the ascending colon with valves and give it a powerful muscular development? The answer is to be found in Hydrostatics.

Peristalsis, the great and perhaps the only factor in the propulsion of the contents of the small intestine, has hitherto been thought to occupy the same position in relation to the large bowel. But the structural and other differences between the two are so marked that the subject is at least worth investigation. Thus, while the small intestine is very mobile, the large is practically fixed. The one has a small lumen with thin liquid contents, the other a very large lumen and dense contents. In the one, the presence of bodies resembling fæcal lumps would immediately excite violent peristaltic contractions; in the other, they usually repose in perfect peace. The interior of the one presents no obstacle more important than the yielding *valvulæ conniventes*, while that of the other

is interrupted by fixed ridges and saccules. The one has an evenly diffused and highly useful muscular coat, the other an arbitrary arrangement of the longitudinal fibres in bands, and of the transverse in constrictions or over saccules, the latter being spread so thinly that it is difficult to conceive of the possibility of complete occlusion anywhere. Finally, while the course of the one is intelligible, that of the other is paradoxical.

The last two points must be considered in more detail. The peculiarity of arrangement of the circular fibres has, I believe, not hitherto been described, or at least has had no significance attached to it. They may be divided into saccular and constrictional. But in neither case are they "circular." They are arcuate; the weak saccular fibres forming an arc of about 125°, the stronger constrictional fibres an arc comprising about 100° of a larger circle. But these arcs are not simply parts of a circle which is interrupted by

the longitudinal bands; for the two ends of a constrictional arc would, if continued across the tæniæ, frequently strike the middle of a saccule and only rarely would they be in a line with another constrictional arc. Annular constriction, therefore, is almost impossible in the large intestine. In a specimen now before me, for instance, a transverse section of the colon starting at a constriction cuts through the middle of the saccule behind and through an intermediate point in the third saccule; but there is nothing like a spiral or helical arrangement. The disposition is disastrous for effective peristalsis, but advantageous for rigidity. I notice, too, that the saccules differ very much in size, a single saccule in one column frequently lying in juxtaposition with two smaller saccules in the next. The reason for the arrangement of the longitudinal fibres in bands has long been a mystery. It has been suggested that they contract over a fæcal lump and propel it by subsequent elongation. Not

a very happy idea, for it makes propulsion dependent, not upon muscular *contraction* which would have some power, but upon muscular *relaxation* which would have little or none. I shall show later that the tæniæ or longitudinal bands are normally in a state of tonic contraction—another condition distinctly unfavourable to peristalsis.

The tortuosity of the course of the small intestine is compensated for by that free mobility which enables it to take advantage of the force of gravitation. The large intestine, on the other hand, follows a course so extraordinary that the contents of the ascending colon, in man, have to be propelled against the force of gravitation for fifteen hours out of the twenty-four, and, in cases of orthopnœa, continuously for many weeks or months! Yet constipation is not a special feature of orthopnœa. It is true that the blood has to be propelled against gravitation in some of the veins; but these are provided at frequent intervals

with valves, while the ascending colon, with its relatively immense bore and its scarcely less fluid contents, has nothing but the remote ileo-cæcal valve to depend upon. Then again, how comes it that the cæcum is so frequently found empty. Professor Shepherd* says: "In my long experience, I have never yet seen at a post-mortem, in the dissecting room, or at an abdominal operation, such a thing as a loaded cæcum. . . . Unless there is some obstruction lower down, the cæcum is nearly always empty." But in a body recently erect, how, on the exclusive peristalsis theory, can the ascending colon be found full and the cæcum empty, although no valve separates them? I submit that those who insist that peristalsis alone suffices for propulsion in the large bowel must either explain these difficulties or abandon their position. The *onus probandi* lies with them.

But I shall be told that peristaltic move-

* "Encyclopædia Medica," Art. Appendicitis.

ments have been actually observed in the large intestine. This I do not deny. Nor do I deny that they have some effect, especially in the descending colon, and even in the ascending colon when the trunk is horizontal. The maximum effect is attained when the bowel is in a state of irritation. But if peristaltic movements were all-sufficing they would have to be very much stronger than those of the small intestine, otherwise they could not possibly overcome the many obstacles detailed above. Singular to relate, however, all observers agree that they are weaker! Thus Boas* says: "The small intestines are chiefly concerned with peristalsis." Nothnagel† says: "The movement of the small intestine is incomparably livelier than that of the large," and Braam-Houckgeest‡ relates an experiment in which, after injection of sulphate of magnesia into the stomach, the peristaltic move-

* *Darmkrankheiten*, 1901.

† *Physiologie des Darmes and Allgemeine Pathologie, Band XVII.*

‡ *Pflüger's Archiv, Band VI.*

ments ensuing stopped short of the cæcum, and the whole large intestine showed no special movements even after two hours. Many experimenters, like Nasse * and Martin,† hardly mention the large intestine at all. The situation is summed up by Landois and Sterling thus: "In the large intestines the movements are more sluggish and less extensive," and by Michael Foster in these words: "The movements of the large intestine are simpler and not so vigorous since, relatively to the diameter of the tube, the amount of muscular fibre is less." The powerful snake-like movements observed in cases of sigmoid obstruction are due, I believe, to causes which I shall explain later, and are not true peristalsis at all. Neither, I think, are the movements of the saccules. They are described by Boas ‡ as "depressions and prominences of the saccules, following

* *Beiträge zur Phys. der Darmbewegungen.*
† *Ueber die Peristaltische Bewegungen.*
‡ *Op. cit.*

each other in regular succession," and the inference drawn is that the contents of one saccule are driven into the next. It is difficult to believe this, and I am more sceptical than ever since I noticed that the saccules of one row are not necessarily opposite those of the next. It is far more likely that the saccular movements in the large intestine take the place of the pendulum movements in the small, and that the function of both is to favour absorption by agitating and mixing the contents of the bowel.

The fact is that peristalsis in the large intestine has never rested upon scientific proof, but has been thoughtlessly assumed to be all important by a false analogy between the two great divisions of the bowel.

Peristalsis in the large intestine may be one of the causes of the propulsion of its contents, but it is not the only one. There are two others—I might say three—of great importance.

If we look upon the junction of the two

bowels as a piece of machinery with a feed-pipe (the ileum) opening into a large cylinder (the full cæco-colon), it is impossible to resist the conviction that we have before us all the elements of hydraulic construction; and that, should there be a block in the colon, considerable hydraulic pressure will be brought to bear upon it. The ileo-cæcal opening is slit-like, but is equal probably to a circle one centimetre in diameter. Its area (πr^2) therefore will be 78 square millimetres. The ascending colon is about $2\frac{1}{2}$ inches, or 62 m.m., in diameter, and consequently its sectional area will be 3020 square millimetres; the force of the stream, therefore, for propulsive purposes will be multiplied 38 times. Should the obstruction be in the descending colon, which is of smaller diameter, the hydraulic gain will be somewhat less. The great force exercised is well shown when the obstruction is complete, such as that caused by a volvulus between the cæcum and the ascending colon. The degree of

dilatation of the cæcum under these circumstances can only be described by the word gigantic. And no wonder, for the pressure exerted inside a closed vessel, such as the cæcum then becomes, must be calculated as surface area and not as sectional area. Thus if the distended cæcum be regarded as a sphere five inches, or 125 m.m., in diameter — and it is often much larger than this—the surface area ($4\pi r^2$) will be 96,648 square millimetres, and the force of the flow through the ileo-cæcal valve will be multiplied over 1200 times! The value of hydraulic pressure in propelling the normal intestinal contents will be referred to in speaking of the next great force—the syphon.

The hydraulic construction of the ileo-cæco-colon is very widely spread in the animal kingdom. Utilising chiefly museum specimens and plates such as those in Treves' book and in Ellenberger and Baum's Handbuch, I find the following animals so endowed: the hog, kangaroo,

agouti, horse, hyæna, Mangaby monkey, spider monkey, gibbon, lemur, the troglodytes and the ruminants. Had I the time, I am sure I could extend the list almost indefinitely, but these examples will suffice.

Reflecting on the difficulty of believing that two bodies so different in structure as the large and small intestines could fulfil their functions in an identical manner, it occurred to me, from a consideration of its course, that the large intestine might act as a syphon. It certainly bears a remarkable resemblance to one. A syphon consists of a reservoir, a short ascending tube, and a long descending tube. So does the large intestine. The reservoir is the cæcum, the short ascending tube, measuring eight inches, is the ascending colon, and the long descending tube is represented by the combined descending colon and rectum; the two together measuring about sixteen inches, so that *cæteris paribus* efficient syphonage would be inevitable. The

transverse colon has been left out of the account, because it is horizontal; and the sigmoid flexure, because its curves would neutralise each other. Neither would present any obstacle to syphonage.

There is, however, one other condition necessary to syphon action in that there must be a certain degree of rigidity of its walls. Does the large intestine fulfil this condition? Certainly not, if it resembles this organ as seen *post mortem*, or even under anæsthetics. But does it? If so, how is it that the transverse colon, which, according to Treves,* averages twenty inches in length, yet occupies a site measuring about half this? Having before me a well-developed young man with a stature of five feet nine inches, I took a twenty-inch tape and hung it U-shape from the tips of the eleventh ribs. It reached a point one inch *below* the pubic bones! Is it likely that the colon ever occupies this position in health?

* "Surgical Applied Anatomy."

In another experiment upon a body propped up in a sitting posture, having ligatured the rectum, I divided the ileum, and inserting a syringe in the distal end, proceeded to fill the large intestine with water. The ascending colon bellied out, elongated itself and became tortuous in course. Then the transverse colon lengthened itself, and, leaving its bed, moved about like a great snake; finally, it hung in curves nearly down to the pubes. The descending colon followed suit, behaving like its fellow; and the sigmoid flexure rose and partially straightened itself. The total result was that the bowel became greatly elongated, and the saccular divisions wider apart. The colon, which *in situ* had measured 22 inches, now measured 36 inches. Surely it is unreasonable to suppose that, in the living subject, every time the large intestine fills, it leaves its bed and elongates itself with such facility as this? If it could, arboreal animals would have been long extinct, and gymnastic

and sporting exercises an impossibility. Imagine a football team handicapped with this disability! But what, then, keeps it in its place? The mesocolon would at most dispose it in waves, and was, moreover, not interfered with in the above experiment. If due to elasticity, this would persist after death. There is only one force which ceases to act with death—muscular contraction—and the only muscles that could, by their contraction, shorten the bowel are the longitudinal bands. Intermittent or occasional contraction would not suffice. The conclusion is therefore inevitable that the large intestine is kept in its place by tonic contraction of the longitudinal bands. Thus the sphincters can no longer be regarded as isolated examples of tonic contraction, and this is perhaps a gain; for solitary exceptions in science are very vexatious to the philosopher, as witness the behaviour of the element radium. But I shall be told that, since the longitudinal fibres of the colon

and rectum are continuous, one would expect to find some signs of tonic contraction in the latter, and this would be easy to demonstrate. It is. For what else can account for the continuous retraction of the anus which is so marked a feature in young adults? It cannot be due to elasticity, for it disappears under chloroform and after death. No vacuum is possible in that situation. Nothing, then, but tonic contraction of the longitudinal fibres of the rectum can account for it, and this conclusion is confirmed when in a young adult the rectum is examined through the vaginal walls. Not even an ampulla can be detected thus. When the "balance point" (to be explained later) is once passed, rigidity is no longer essential; for this reason the tænial arrangement of the longitudinal fibres is gradually lost in the sigmoid flexure.

The conclusion that the longitudinal bands must be tonically contracted, arrived at by inductive reasoning, appeared in the

pamphlet which was issued early in December 1902, and although it was accepted by many, yet St. Thomas is ever the patron saint of science and I thought it desirable to have it confirmed by ocular demonstration. With this view I wrote to Dr. Brodie, then director of the Physiological Laboratories, Victoria Embankment, asking him to look out for the phenomenon. I had not long to wait, for on January 31 I received a letter from him giving his conclusion in the following terms: "I think there is no question whatever but that the longitudinal bands are tonically contracted." The tonicity must therefore be regarded as an established fact. That being so, let us see how far it would secure rigidity of the bowel walls. First, there is the resistance of the bands themselves; secondly, there is the increased thickness of the walls consequent upon the shortening; thirdly, the saccules, as figured roughly on the blackboard shown in the frontispiece, will be so altered by the shortening that not

only will the dissepiments or internal ridges be deepened, but there will be contact between the rising walls of adjacent saccules. This will make for rigidity in the same way that the walls of a concertina are more rigid when the instrument is nearly closed than when it is extended. Further, apart from tonicity, the blood-vessels of the bowel, arranged as they are in rings, will bestow some rigidity when full and tense as in life. The fact is, our ideas of the large intestine have been based far too exclusively upon its appearance in the cadaver and in patients under anæsthesia.

But, since I may claim that the existence of hydraulic action in the bowel is indisputably proved, it is clear that that alone would involve the necessity for some rigidity in the walls apart from any question of syphonage. Otherwise, the force, multiplied hydraulically, of the stream from the small intestine would expend its energy uselessly or injuriously

upon lateral expansion of the colon instead of upon propulsion of the contents.

It is true that it is not easy to detect anything like rigidity in the living subject —it is most marked when the patient sits erect with the knees drawn up—but absolute rigidity is not required. I find, for instance, that a length of garden hose forms a very good syphon. It must be remembered, too, that the rigidity of the bowel is in a large measure internal. The ridges are internal and even the longitudinal bands are overlapped by the soft saccules as a result of the shortening. The solid cylinder felt in acute colitis is produced by rigidity *plus* tumefaction.

Having disposed of the question whether the large intestine is structurally a syphon, the question remains: Are the contents themselves susceptible of syphonage? Instead of endeavouring to settle the various points by reference to the laws of Physics, I prefer to describe a few simple experiments and rely upon their results

to dispose of the following difficulties. Although rather trite, they will have more weight with those who have forgotten some of their Physics.

(1) *Can a syphon act when its contents are partly gaseous?* First, I agitated some glycerine with an equal quantity of air in a bottle until it was full of minute bubbles. Their presence made no difference to the flow through a syphon. Later, I withdrew the short tube from the glycerine at intervals and, in this way, caused to enter the syphon three air spaces, each about half an inch in length. The result was that the current, instead of being stopped, was greatly accelerated until the spaces entered the descending tube, when, although it slowed down, the stream continued to flow freely. The same result was obtained when a single air space three inches long was admitted; but, in a third experiment, when the air space measured five inches, this travelled only as far as the commencement of the descending tube when the flow

came to a stop. The syphon had, like the large intestine, a long limb, twice the length of the short one—eight inches and four inches respectively—an air space five inches long was therefore greater than the difference between the two limbs. The law governing the matter may be expressed thus: *A syphon containing gas and fluid will act, providing the total gas space falls short of the difference in capacity between the long and short limbs.* The intestine, it may be here remarked, differs from a glass tube in that it has means of expelling the excess of gas.

2. *Will a syphon act when there is no tube dipping deeply into the reservoir?* The question is trivial, but it is well, perhaps, to answer it practically. In a further experiment, then, I kept the orifice of the short tube only just in contact with the glycerine. The flow of course continued just the same.

3. *What effect has fluid of a greater density in the descending tube?* Owing to the absorption of some of its water, the

contents of the descending colon are denser than those of the ascending colon, and this greater density, provided it is not sufficient to stop the flow, is an advantage rather than the reverse. To demonstrate this, I filled the descending tube with glycerine sp.gr. 1260, and the remainder of the syphon with water with the result that the flow was greatly accelerated.

But if the large intestine is a syphon it must be an intermittent one, for the cæcum or reservoir is practically a closed sac ; or, at least, a sac which would be emptied by syphonage far more quickly than the inflow from the ileum could replace the loss. The question arises, therefore :

4. *What happens when the cæcum is evacuated?* To answer this, I fixed a thin rubber ball to the short limb of a syphon, and filled the syphon by inverting it. On re-inversion, syphonage took place, and the ball collapsed. (See Frontispiece.) After syphonage of the intestine, therefore, since the cæcum is prevented by its

structure from total collapse, a Torricellian vacuum forms in it for a time, the ileum being closed either by its first kink or by the extroversion of its mucous membrane, like an incipient intussusception (for which lesion a vacuum might account).*

5. *Does the sigmoid flexure confer any advantage?* To determine this point, I repeated the last experiment with a syphon which was unprovided with a sigmoid bend. The ball collapsed as before, but almost immediately refilled. The reason for this I found to be that after syphonage, although the descending column, as usual, balanced the ascending one, the action of the vacuum speedily turned the balance in the wrong direction, so that back-syphonage ensued. It is probable, too, that with a straight descending tube the rush carries with a jerk a little more than it should, and leaves the balance in favour of the ascending fæcal column and vacuum

* A bellows spray furnishes the best air balls; the thinner one showing the collapse, the thicker one the vacuum.

power combined. Under normal conditions the resistance of the bent column in the sigmoid flexure counterbalances the action of the vacuum. Under certain circumstances, however, back-syphonage may take place notwithstanding the presence of a sigmoid flexure. The small scybala, for instance, sometimes found in the cæcum may owe their presence there to back-syphonage. The question will arise again in connection with appendicitis.

There has been much discussion as to the nature of the curves of the sigmoid. Treves says that they do not constitute an **S**, but that, in conjunction with the first portion of the rectum, they form a capital omega, which, according to the figure of it in the plate, is inclined with the convexity upwards and inwards. But, owing to the tonic contraction of its longitudinal fibres, the curves of the organ must be smaller and shorter in the unanæsthetised living subject than after death. It is in the sigmoid flexure that the tæniæ spread out

so that the longitudinal fibres become evenly distributed. This causes a loss of rigidity and favours distension, and, for this reason, it is in the sigmoid flexure that accumulations are chiefly found. The fact is generally attributed to the curves, but were there the same rigidity as in the transverse colon the contents of the bowel would not necessarily accumulate.

6. *Is it possible to demonstrate syphonage in the dead body?* Evidently not, since the rigidity of the colon walls is due to tonic muscular contraction. I made some experiments before I discovered this fact, and in one case I thought I succeeded. This was in a newly born child. There are advantages and disadvantages at that age. On the one hand, the course of the colon is so irregular that it must be supported before it will assume what from the Greek letter Π may be termed the pioid form. On the other hand, there is no difficulty with the gas, for the gut is absolutely full of meconium which, when cold,

sets and forms a soft waxy cast of the bowel. Fixing the body in a sitting position, I supported the arch of the colon and, dividing the ileum, inserted in it the nozzle of a syringe. Finding the resistance great I divided the rectum, but with no better result. Then I thought that perhaps the meconium was too solid, so I warmed the bowel. The resistance disappeared, syphonage started, and the cæcum collapsed. It looked like a successful experiment, but subsequent reflexion and other experiments made me doubt it, and I feel sure now that I must have warmed the surface only of the meconium cast, and that what I really dealt with was not fluid, but a flexible waxy cylinder, or, at the most, fluid surrounding a waxy core. Still, if the resistance of the cylinder be regarded as compensation for absence of rigidity, success of a kind may be claimed for the demonstration.

7. *Can syphonage take place when the transverse colon shows a* V*-shaped bend?*

Yes, provided the bend be not due to loss of rigidity—and I suspect this is often the case. To convince others, I used a syphon bent to represent this variation, and obtained the usual result.

8. *What happens when the long limb of a syphon is of smaller calibre than the short one?* Retardation of the flow. I proved this by inserting a cork bored by a glass tube in the lower orifice of a syphon. The stream flowed perfectly well, but slowly. The reason for settling this point is that the calibre of the descending colon is smaller than that of the ascending colon.

9. *Is not the clay-like consistence of the contents of the descending colon a bar to syphonage?* Not unless the fæces are too solid to flow; and this is, of course, a condition precedent with every syphon. It must be remembered that the fæces contain an appreciable amount of fat, and that the walls of the lower part of the bowel are well coated with mucus. Hydraulic pressure is

quite sufficient to start the syphon action, and this once started, there will be the added gain of gravitation (Expt. 3). That the more liquid portions of the stool are evacuated while the scybala or other hard accumulations remain—sometimes for long periods—is within every one's experience, and I submit that the fact is much better explained by syphonage than by peristalsis. I do not pretend that the following experiments reproduce the situation found in nature, but they throw some light upon it. In the first, I endeavoured to syphon some stiff treacle, and succeeded without any difficulty. In the second, I took some moderately stiff dough and incorporated with it about 5 per cent. of petroleum. I found it rather difficult to get into the syphon, but saving a few air spaces I managed to fill the descending tube. On syphoning water through it, air came away first and then stained water. While the latter was passing, consolidation could be seen to be taking place and, this

complete, the dough came away like a formed motion.

Dr. Goodhart * speaks of a condition in which the fæces are observed to be so adherent to the colon walls as to be almost incorporated with them. I have been asked whether this would not affect syphonage? It would undoubtedly retard it and might prevent it. But I doubt whether the condition is possible in the living subject. Absorption probably reaches its maximum activity in the descending colon, and such a state of things would be inconsistent with it. One would think, too, that the continuous formation of mucus would detach the fæcal matter and prevent adhesion.

I may as well complete this catechism by answering a question that has been frequently put to me:

10. *What about syphonage in such animals as the horse or the cow?* A syphon will not work when horizontal; so that, if

* *Lancet*, 1902.

one existed in these animals, it would be useless because the trunk is always horizontal. It is not to be expected, therefore, that one would be found. If an instance were pointed out to me of its existence in an animal which does not even sit on its haunches, I should simply infer descent from an animal that did.

As no importance has been previously attached to the peculiar "pioid" course of the large intestine in man, I have been unable to get more than accidental help from the writings of others, and I have no time at my disposal for dissections. Now that attention has been drawn to the matter, the information will no doubt soon be forthcoming. I have asked the prosector to the Royal Zoological Society to make notes on this subject.

It appears to be present in the quadrumana, but from Ellenberger and Baum's "*Handbuch der Vergleichenden Anatomie der Hausthiere*," although the information is not given intentionally, I infer that the

arrangement does *not* exist in ruminants, horses or pigs. The course of the colon in the dog is such that there would be powerful syphonage provided that there were sufficient rigidity of the walls; but, since there are neither muscular bands nor saccules, the point is doubtful. What I want to know is this (1) Does it exist in animals which sit on their haunches? and (2) Is it uniformly absent in those which do not? The question is of interest from the point of view of evolution, but has only indirect value as evidence of the existence of a syphon in man. I think I may now claim to have demonstrated that, given the erect position and contents capable of flowing, the large intestine must *of physical necessity* act as a syphon when full.

But, although syphonage is the normal condition in man, it is by no means constantly present. One cause of absence of syphonage lies in a general relaxed state of the muscular system. The condition extends to the longitu-

dinal muscular fibres of the rectum to some extent as shown by the absence of the normal anal recession. I would suggest, too, that the maximum pressure of the corsets lies directly over the transverse colon and may possibly be another cause of paresis of the tæniæ. In both cases rigidity will be impaired and syphonage made more difficult, if not impossible. The treatment consists in massage over the transverse colon, plenty of fresh air and exercise, and for a drug —nux-vomica. To avoid the ill-effects of overloading the bowel, a full dose of Apenta water should be given warm twice a week and sipped while dressing.

A third cause of absence of syphonage is *excess of gas*, as shown in the experiment with air bubbles in glycerine (Expt. 1). If the amount is only moderate, it will be got rid of by peristalsis. The advent of the solid motion is then heralded by the escape of flatus. When it is greatly in excess of the syphon maximum, a portion may be

got rid of in this way; but, the amount remaining being still in excess, syphonage cannot take place. The patient then complains that instead of a proper evacuation, he has passed "nothing but wind." Massage and carminatives are here the indications.*

But the commonest cause of the absence of syphonage is excessive dryness and solidity of the fæces. The condition is very common in patients who are taking opium, and is then due, not to any increased rate of absorption in the descending colon, but to longer exposure to its absorptive action through inhibition of peristalsis in the small intestine. The same is true of many cases of constipation (*q.v.*). Belladonna lessens the constipating action of opium. But notwithstanding some prejudice against it, there is rarely any

* The reason why syphonage is not started by lateral inclinations of the trunk is that the gas in the transverse colon is normally in such excess as to inhibit syphonage (Expt. 1).

objection to combining an aperient such as cascara with opium.

The point in a syphon which it is necessary for the descending current to pass in order to start the flow, may be termed the *balance point.* The balance point in the bowel is near the junction of the descending colon with the sigmoid flexure, the latter being a pelvic organ (Treves).

The following is the cycle of events in health. After the partial evacuation of the large bowel consequent upon defæcation, syphonage is stopped, a vacuum is formed in the cæcum, and there remains a fixed fæcal column. This extends from the lower part of the ascending colon to a corresponding point in the descending colon so that the column in one supports and balances that in the other. To be precise, the descending fæcal column must for a time be a little longer than the ascending one, for it has to balance, in addition, the tug of the vacuum in the cæcum, and if the vacuum be broken suddenly the portion of column balancing it may come away as a small stool soon

after the principal one. Next, the vacuum is broken, partly by gas, and partly by the resumption of the flow from the ileum. Whether or not gas is secreted by the intestine is a disputed point; but if anything could extract it from the blood it would be a vacuum. Then the cæcum slowly fills—slowly because, on account of its abundant supply of lymphatics, concurrent absorption is considerable. When the cæcum is full, the stream, like the bore of a tidal river, enters the ascending colon. Here it finds the fixed fæcal column, but this is attenuated by the absorption that has been going on and the first energies of the advancing stream are devoted to consolidation and to the expulsion of the excess of gas. But there comes a time when it meets with the full resistance of a balanced fæcal column. Here hydraulic pressure comes to its aid and the bottom of the descending column is pushed past the balance point. Syphonage then ensues, the rectum is filled and the cæcum emptied. Should the contents of the

bowel be very liquid the entire sixteen inches of the descending limb will be available, and syphonage may be so strong and sudden as to empty a portion of the ileum, the consequence being an involuntary evacuation. But, in general, the fæces being more or less clayey, syphon action will stop short at the internal sphincter, so that its force is expended upon distension of the ampulla. Syphonage is then more deliberate and the net result is that the contents of the cæcum are transferred to the ascending colon while those of the sigmoid flexure are transferred to the rectum. This ends the involuntary act.

The voluntary part, or defæcation, then begins, or should begin. Defæcation is accomplished by reducing the cubical capacity of the abdominal cavity. The diaphragm is made to descend by an inspiration and is fixed in that position by the closure of the rima glottidis. This gives a rigid roof to the cavity. The levator ani then contracting encroaches upon the pelvic space and forms a rigid

floor. Lastly, the abdominal muscles contract and so compress the sides of the abdominal cavity that the contents of the rectum, assisted by the contraction of its muscular walls, follow the path of least resistance and escape from the anus. The collection in the rectal pouch is that most susceptible to pressure and escapes first; there is usually then a pause during which more fæces enter the pouch from the columnar portion of the rectum. Another voluntary effort expels the second collection, and perhaps a third or a fourth effort may be necessary; and, after all, in certain individuals some fæces may be left in the cylindrical portion of the rectum and excite discomfort. Thereafter the cæcum slowly refills and the other steps follow. In diarrhœa, the time occupied by the refilling is necessarily much shortened, so that syphonage recurs at frequent intervals. But in health, owing to extensive concurrent absorption, the refilling process is slow. The reason why the normal time or an evacuation is in the morning is that

it is only on resuming the erect position that syphonage becomes possible. That it is after breakfast is due to the increased volume of the flow through the valve consequent upon the pressure from behind. The pressure in its turn is due to the ingestion of food and drink which excite peristalsis in the small bowel and increase the total contents. The latter cause alone is that usually given; but if only this be true, why does not the daily evacuation come after dinner, which is the largest meal taken and which is often followed by coffee and a cigar? Morning diarrhœa is also connected with the resumption of the erect position.

I believe it is of very great practical importance to distinguish clearly the difference between the involuntary act, by which the rectum is filled, from the voluntary act, by which it is emptied. So much so that, objectionable as the practice is, I should like to be permitted to coin a distinct word to express the former act, and therefore suggest "fæcation" for the action by which

the rectum is filled. I have described this as involuntary advisedly. Syphonage is of course involuntary; but, apart from that, I am of opinion that considering (*a*) the remoteness of the ileo-cæcal valve; (*b*) the absence of valves in the ascending colon; (*c*) the ease with which the large bowel can be elongated; and (*d*) the faulty purchase or *point d'appui* afforded by the elastic cushion of small intestines, it is very improbable that propulsion of the colon contents can be effected by straining. Indeed, it seems to me that unless the gut is absolutely full, straining is as likely to force the contents the wrong way as the right.

Straining is not without its dangers especially in elderly people, and in my experience patients usually get on much better, even as regards their bowels, if they defer straining until they are conscious of the presence of fæces in the rectum. The point, which is of importance in the treatment of constipation, will again be alluded to.

The vacuum in the cæcum has great potentialities for good or evil. Its value in the early treatment of appendicitis, where it affords the physician a chance of *empyting the appendix by suction* and thus furnishes a new weapon to his armamentarium, is obviously great. That and its relation to typhoid will be dealt with later. On the other hand, I have shown that under certain conditions back-syphonage takes place and the appendix is *filled* by suction. Back-syphonage of this dangerous character is only possible while the vacuum persists. There are no means of ascertaining how long this is; but it is not likely to exceed an hour. It is disastrous because, since the cavity of the appendix shares in the cæcal vacuum, fæcal matter and foreign bodies may be sucked into it. In his recent Hunterian lectures, Mr. Eccles, after remarking upon the smallness and inaccessibility of the appendicular orifice, says, "it is wonderful how the various pointed foreign bodies found within the lumen of the tube have

discovered the narrow aperture, cast round as it is with everything that would seem to block the way." May I venture to suggest that a good explanation is afforded by an appendicular vacuum? In back-syphonage, the vacuum is suddenly broken by an inrush of fæcal flush which may contain foreign bodies in suspension. Mr. Eccles also expresses the opinion that a narrowing of the orifice with its risks of complete closure is more dangerous than a dilatation. Even so, the frequent creation of a vacuum in the cæcum is a good method of keeping the aperture patent. When fæcal concretions in the appendix have no foreign nucleus, I take it that they have their starting-point in the unabsorbed residue of simple fæcal fluid and grow by lamination from subsequent incursions of the fluid, in the manner suggested by me many years ago to explain the growth of laminated blood-clot.*

Back-syphonage, as has already been explained, is started by the tug of the

* *Lancet*, vol. i. 1876.

vacuum when something arises to reduce the downward pressure of the fæcal column in the descending colon. It might arise when the syphonage acts with great suddenness so that not enough of this fæcal column is left to balance the ascending column. Possibly, too, forcing the rectal gas back into the colon may disturb the balance in the same way, as may also the postponement of the call to defæcate; the contractions in the rectum then force the stool back into the sigmoid flexure and bring pressure to bear upon the gas separating it from the descending fæcal column, thus disturbing the balance in the wrong direction. Ordinarily, however, the result of the deferred evacuation is to distend the walls of the sigmoid flexure so that no upward pressure is exerted.

But, in addition to Peristalsis, Hydraulic Pressure and Syphonage, a fourth propulsive force is held in reserve for cases of serious intestinal obstruction. It has been pointed out in an earlier part of the book that while the length of the large intestine

when drawn out after death is, minus the sigmoid flexure, about fifty inches, yet, measured *in situ*, in the dead body before disturbance of the viscera it is only about thirty-three inches. Further, it has been demonstrated that the large bowel is fixed at the latter length by the tonic contraction of the longitudinal bands. Now, since there is a limit to the resistance of these bands, it is evident that when there is complete obstruction, *e.g.*, in the sigmoid flexure, the flow from the ileum, with its power multiplied hydraulically, will in time overcome this muscular resistance. And, further, that as regurgitation through the ileo-cæcal valve is difficult, elongation must necessarily ensue. The restraint imposed by the mesocolon will throw the bowel into more and more undulations, and the effect of the straining of the bands to bring the gut back to its normal length will produce snake-like movements. These have hitherto been described as "visible peristalsis" of the large intestine, but they have nothing in common with true peristalsis. When,

however, the obstruction is only partial, this resistance on the part of the tæniæ to the lengthening of the bowel will aid in expulsion of its contents. Thus a useful force is held in reserve. Sir Frederick Treves gave unconscious support to this view many years ago. In his Hunterian Oration he says: "The longest and most irregular transverse colons are met with in subjects in whom the large bowel is distended and occupied by much fæcal matter." The immense muscular hypertrophy met with in some cases of chronic sigmoidal obstruction is due to the fact that since neither syphonage nor hydraulic pressure is available, all the work is thrown upon the muscular coat of the bowel. The activity of the tæniæ cannot go on indefinitely, the time will come when their resistance will be worn down and paresis ensue. It is when paresis of the bands sets in from this or other causes that the V-shaped bends of the transverse colon arise. I should like pathologists to look out for the V bend in patients who die

having lead-colic. Paresis of the bands in this condition and the consequent elongation would, by increasing the capacity of the bowel, explain both the colic and, in part, the constipation. There may be nothing in it, but it is worth looking for. Further, I should like any one who makes a post-mortem examination upon a man found dead in a sitting posture to look out for the V colon. If the transverse colon were anything like full I should expect it to drop under these conditions. Lemurs and spider monkeys are said to have this shaped colon naturally. Perhaps naturalists will notice whether they die sitting up. If so, this might account for it.

I am afraid I shall be thought presumptuous when I suggest that the long and meandering colon of the fœtus and infant may be due to similar causes. Its length would be accounted for by the fact that the tonic contraction of the tæniæ is not yet developed. Evidence of this is found in the non-retracted state of the anus and

in a similar non-development of tonicity in the sphincters. At birth, too, the large intestine is filled throughout its entire length.

It is just possible that, very occasionally, assistance in the propulsion of the colon contents may be afforded by another hydrostatic principle. It is expressed in the familiar phrase, "Water seeks its own level," and would only apply when the stomach, as well as the whole length of small intestine, is full—the stomach in the erect position being higher than the transverse colon.* This additional force, however, must be classed with the curiosities of Physics; for the jejunum, as its name implies, is practically always found empty, and, even were the whole tract full for a time, the chances are that it would be speedily emptied by vomiting.

But, although the large intestine has hitherto been but little understood, and no

* I cannot recall now whether the copious draught forced upon the *Fuchs* at a German *Kneip* had this effect. It would be interesting to find out.

true scientific conception of the significance of its parts has existed, yet there is a vast amount of empirical knowledge based upon the observations of centuries and, therefore, *primâ facie* true. I propose, then, to consider in detail the bearing of these conditions upon the hydrostatic principles here enunciated, and I shall take them with special reference to Constipation, Purgation, Typhoid Fever, Intussusception and Appendicitis.

Constipation. *Exercise.*—This is of well-known benefit to most persons of constipated habit. It would favour syphonage, first, by preventing an accumulation of flatus over the working maximum; and, secondly, by improving the tone of the longitudinal bands. If I may venture to give what is rather a clinical impression than a scientific deduction, I should say that it is less beneficial in thin subjects. I have known many thin men who suffer from constipation notwithstanding that they take abundant exercise. The fault in such subjects lies, I think, in insufficient liquid, and

perhaps they lessen this still further by the perspiration which exercise evokes.

Massage.—This, like exercise, improves the tone of the longitudinal bands and expels the excess of gas; but, as I shall show later, it is not without its risks. In addition, it excites peristalsis in the small bowel.

Residual Food.—This is undoubtedly a great adjuvant to peristalsis. It has been generally supposed to act upon the large intestine; but, to my mind, its action must be far greater in the small intestine. The contents are much more fluid and therefore in greater contrast with hard undigested bodies. The calibre of this gut, too, is so small that there must be much more frequent contact with the walls, and consequently more irritation. Twenty "fig-seeds" might produce a good effect in the small intestine, but they would be quite lost in the large bowel. Rarely, in that thick menstruum, would more than one or two be in contact with the wall of the colon. Moreover, by the time they emerged from

the ileo-cæcal valve, not only would the soaking have softened them to some extent, but each seed would be invested with a coating of fæcal matter. Finally, the large intestine is very tolerant of the presence of no less hard fæces. The vigorous peristalsis of the small intestine consequent upon this irritation naturally increases the rapidity, force and volume of the flow through the ileo-cæcal valve and thus favours both syphonage and hydraulic pressure.

Deficiency of Liquids in the Diet.— Women, from motives of modesty, are the great offenders in this respect, especially when away from home. If there is insufficient water in the colon both syphonage and hydraulic pressure will be at an obvious disadvantage. The remedy for this is to drink more; and a tumbler of hot water fasting suits many people admirably. It is more efficient when sipped than when drunk quickly. Sipping is said to increase peristalsis, but I have never come across any proof of this. I think it much more

likely that, where an appreciable quantity of water would be stopped by the pylorus, a sip would escape its vigilance. It would then enter a part in which it would be hydrostatically advantageous. At the best, however, it is liable to be absorbed prematurely, and I have therefore recommended more colloid drinks with a view of retarding absorption. For delicate people a basin of *consommé* or gelatinous soup taken fasting after rising has an excellent effect. For others I have recommended that, instead of plain water, they should soak a teaspoonful of shredded gelatine in cold water over night. In the morning, throwing away the unabsorbed water, they should fill up the tumbler with hot water and dissolve the swollen gelatine by stirring. Sugar and lemon juice may be added if desired. But where the deficiency of water lies in the fæces themselves, which then become too hard to flow, water and other plain liquids have little softening action. Sugar has most effect in this direction, especially in the form of jams, conserves, stewed or

candied fruits, prunes, figs, &c. These substances commonly contain indigestible residua and are of advantage, too, in that way.

Intestinal Obstruction.—Should there be a stricture in the colon, it is evident that the hydraulic advantage will be lost *pari passu* with the reduction of the lumen, and that when the size of the stricture equals that of the ileo-cæcal valve there will be no gain at all. This makes it all the more necessary to invoke syphonage. In addition, therefore, to the usual treatment of keeping the fæces liquid by hydragogue aperients, it is essential to forbid the patient to lie down. When in bed he should maintain an angle of at least 45°. In this way, whenever the gut is sufficiently full to excite it, syphonage will be taken advantage of.

In the treatment of constipation, it is most important to distinguish between *defæcation* and, what I have ventured to term, "*fæcation*," meaning by the latter the act of filling the rectal ampulla. The treatment in the two cases is very different,

though in many cases the conditions must be treated simultaneously. For impaired power of expulsion from the ampulla (defæcation proper), aloes, cascara and glycerine suppositories are indicated, while for impaired power of filling the rectum, watery enemata and hydragogues are usually the most effectual.

Purgatives.—These are divided into hydragogue and muscular. Whether the action of the hydragogue purgative be expended upon the large or the small intestine the result will be to favour syphonage, for in either case the large bowel will be filled more rapidly and with more fluid contents. The muscular purgative will help syphonage directly only when it acts upon the small intestine, for the strong peristaltic contractions of the part will increase the force and rapidity of the flow through the ileo-cæcal valve. Indirectly, it may favour syphonage by starting peristalsis in the sigmoid flexure, thus removing the resistance in front, and also by getting rid of the excess of gas.

Sir Lauder Brunton remarks upon the curious fact that if a patient takes a dose of sulphate of magnesia "just after he has risen in the morning, it will cause a free fluid evacuation within an hour; but, if he takes the dose when he is just awake, and lies still for an hour or so afterwards, it is very likely he will not get an evacuation of the kind desired." I am not aware that absorption is more rapid in the recumbent than in the erect position, and my explanation is that, in the first case, the patient is erect when the large bowel fills, and so gets the benefit of syphonage; while, in the second case, much of this extra fluid would be re-absorbed, and what is left on rising might not be enough to excite syphonage.

Enemata. — The object of a large enema is to assist "fæcation"; of a small one, to assist defæcation. If the rectum is already loaded, a small enema of glycerine will empty it, and a large one will do harm by stretching and weakening the muscular walls of the rectum. A large

enema administered to a patient who is confined to the recumbent posture acts by elongation of the colon, through the energetic attempts of the tonic longitudinal bands to regain their normal position, and bring the capacity of the colon back to its proper amount. The liquid injected is therefore forced out again, and it carries with it a portion of the fæcal contents. Whenever possible, an enema should be given with two objects in view: first, to soften the fæces; and, secondly, to excite syphonage. To have a softening effect, it must be retained for an appreciable time; the quantity employed, therefore, should fall short of what would produce elongation of the colon. To obtain syphonage, it is necessary that at the proper time the patient be made to sit up. In order to fulfil these conditions, not more than a pint or a pint and a half of fluid should be used and, for repeated use, soap and water is better avoided; the bowel is already too dry, and why make it drier by using soap? A concentrated emulsion can be made by

beating up the white of an egg with five ounces of Ol. Nucis in a mortar; an ounce of this, mixed carefully with a pint of warm water, makes an excellent enema. When the enema is administered, the patient should lie on the right side with the hips raised, and remain in this position for ten minutes so as to prevent syphonage from taking place while the softening action is going on. At the end of that time he should rise suddenly and immediately sit on the night-stool with the trunk erect, when syphonage will ensue. Should the rectal ampulla be slow in evacuating its contents, he may crouch and strain. The exact quantity needed to get a good result in this way must be proportioned to the probable capacity of the colon, which is, of course, not the same in all individuals.

Glycerine.—This, when administered by a syringe, acts as an irritant and excites peristaltic contractions from the sigmoid flexure downwards. Its action has been said to extend to the duodenum; but, if so, the contraction there is not a factor in the

evacuation of the rectum. The drug acts far too quickly for that. It is quite common to get a satisfactory result from a glycerine suppository that does not burst. It acts then as a mere foreign body, like a piece of soap. Glycerine has no direct influence upon syphonage. It is especially indicated when the power of defæcation proper is weakened, *i.e.*, when there is a difficulty in expelling the contents of the ampulla, and this may happen even when the fæces are semi-liquid. The tone of the rectal ampulla is much improved by injecting a little cold water after every motion, as advised by Mr. Cripps.

Free purgation is commonly followed by constipation for a day or two. This is not easy to explain on the peristalsis view, for the large intestine is almost never found quite empty, and if not empty, why should not peristalsis be set up? On the other hand, the syphon view explains it at once. The renewed action of the bowels is deferred simply because it takes a long time to get the gut full enough to induce syphonage.

Fæcal Accumulation.—This is one of the commonest ailments with which the practitioner has to deal. Its seat is nearly always in the sigmoid flexure, since it is there that the walls of the bowel first lose their rigidity and consequently their resistance to expansion. Rarely there is a large accumulation in the cæcum; but I think it will be found that this only occurs when there is paresis of the longitudinal bands. There is one characteristic symptom of sigmoid accumulation which I have never seen in print (except, of course, in my Index of Symptoms). It consists in a dull heavy pain in the left hypochondrium much aggravated by fast walking. I think it is due to the heavy sigmoid dragging upon the costo-colic ligament—the descending colon being shortened and rigid.

Habit.—It is a well-known advantage to sufferers from constipation to go to stool at the same hour regularly. I am unable to explain the bearing of this fact upon syphonage. Nor is the connection with peristalsis much more evident. It must be

connected in some way with innervation, and this affects even syphonage, for the force which produces syphonage is derived ultimately from the peristaltic action of the small intestine. I would point out, however, that sufferers from constipation consist largely of those persons in whom syphonage is the exception. In some, this is due to the solid character of the intestinal contents, though this is usually secondary to long retention ; in others, to the contents being insufficient to excite syphonage ; and in a third group, where there is a general flabby condition of the system, to want of tonicity of the longitudinal bands. The reason of the customary evacuation taking place in morning has already been explained.

Intussusception. — I have already hinted that the vacuum produced in the cæcum by syphonage is probably the starting-point of this condition by the tug which it would exert upon the interior of the small intestine. If the first protrusion sufficed to block the orifice, the pressure from behind, acting upon the less firmly fixed

cæcum of a child, might easily invaginate the valve and a portion of the cæcum around it, and, finally, even cause the valve to protrude from the anus and produce the commoner form of intussusception. But, if the orifice were not blocked—and this would be more likely the case, one would think, in a wasted infant—the stream passing through would cause syphonage at intervals, and each syphonage, making a fresh tug, would drag a little more of the ileum through the valve, so that ultimately a considerable length might be found in the colon. The explanation must be taken for what it is worth; but, so far as I know, no other has been offered except that which is cited to explain every possible phenomenon in the intestine—peristalsis—in this case said to be "irregular." Little can be done medically where the obstruction is complete, but when the second form of intussusception is in question there is one obvious thing to do, viz., prevent syphonage from taking place. This can be done by making the patient

keep the recumbent position. The rule is even more necessary if enemata are employed. Surgeons say that the intussusception when operated upon can usually be reduced with the greatest ease. This is very far from being the experience of physicians. Perhaps the anæsthetic has something to do with the difference. Anæsthesia is, however, not an unmixed advantage when an enema is employed, for the force of this is then apt to be expended upon lateral expansion. Medical treatment may be reinforced by taking advantage of hydraulic pressure. For this purpose the rectal tube should have a small bore and a collar that would act as a valve against the top of the internal sphincter—something in india-rubber on the principle of an umbrella probang would do—then a rather large enema containing some oil emulsion should be administered. The rule, however, still holds good that only a short trial should be given to the medical treatment of this condition.

Typhoid Fever. — In typhoid fever there is a great tendency to overloading of

the cæcum, especially towards the third week. I believe this is due to paresis of the intestinal walls, otherwise it is difficult to understand that Dr. William Ewart's method of emptying it by gravitation could be successful. Such an accumulation obviously increases the risks of a fatal issue. Conversely, its avoidance and, still more, the creation of a vacuum in that situation would diminish these risks. The tension upon the walls of the ileum would certainly be lessened thereby. To obtain this advantage, the patient should be made to sit up at intervals of three or four hours through the day for ten minutes at a time ; syphonage would then have some chance, whereas it has none when the patient is kept recumbent. The state of the heart might, of course, forbid the method ; but rarely in the first ten days, and, later than this, it might not be available, owing to paresis of the longitudinal bands. Cases of typhus ambulans show with what impunity the erect position can be maintained in the early stages.

Appendicitis.—There are several allusions to this condition in the present work, notably under the head of *vacuum.* Whatever may be the case with patients operated upon *between* the attacks—and some of these might have proved unnecessary—there can be no doubt that the mortality of those who undergo the operation *during* the attack is very high. A method, therefore, which offers a good prospect of cure by other means is not to be despised. Of course, if pus has formed, or if perforation is imminent, there can be no question of anything but operation ; but there is reason to believe that both suppuration and perforation might be less frequent if the course here advocated were adopted from the beginning. Broadly speaking, an inflamed appendix may be regarded as a sinus with too small an orifice. Should the orifice close, the appendix may swell up, become gangrenous, and burst. Nothing can be done by the vacuum method when the orifice is closed, though something may be done to prevent it closing. A sinus

and a punctured wound amount to much the same thing surgically, and when the orifice is too small the obvious course is to enlarge it. But this cannot be done in the case of the appendix. But besides enlarging it, there is, in the case of punctured wounds, a successful method adopted by duellists and others, and as old as the days of Queen Eleanor, which consists in sucking or dry-cupping it, and a similar method is possible in the appendix provided its orifice is patent. It has been shown that, when syphonage takes place, a vacuum is formed in the cæcum (Expt. 4); and, if in the cæcum, then in the appendix. The force of the vacuum would probably suffice not only to suck out fluid, bacteria, and small calculi or foreign bodies, but, these once removed, it would cause the appendix to collapse, and thus favour obliteration. The power of syphonage might possibly be increased indefinitely by connecting a tube with the rectum ; but there would be an element of danger in so doing, especially in young people.

The idea that the large intestine might be a syphon only occurred to me at such a recent date that I have been able to make but little practical application of the view to this and the foregoing conditions; I cannot, therefore, pretend to speak from much experience, although such results as I have had are very encouraging. I hope to write from this point of view later, and in the meantime I trust that others will try my methods. The treatment I advocate for appendicitis is this: The patient sits up in bed, continually, as if he were orthopnæic; in this way, he is always prepared to take advantage of syphon action. He is kept on liquid diet consisting largely of Benger's Food and beef tea. Pure milk is better avoided on account of the curd, but peptonised milk may be given. Hot applications should be dispensed with as they may relax the longitudinal bands and lessen rigidity. Morphia is contra-indicated because it diminishes peristalsis. As soon as the patient is seen, a double glycerine enema should be administered. The

object of this is to lessen the resistance in front of the fæcal column. The bowels having acted, at least half an ounce of sulphate of magnesia in a tumbler of hot water should be given, and this may be repeated whenever there has been no action of the bowels for four hours. I am aware that purgatives have been loudly condemned by some in the treatment of appendicitis ; but they have also been extolled by others. Both are right. They are good when syphonage is possible, bad when it is not. The decubitus makes the difference. Enemata are not to be used as they may excite back-syphonage. The only local application advisable is a circular piece of Empl. Lyttæ an inch in diameter. The centre of this should be over Mc Burney's point ; and there is no objection to a pad of cotton wool over it. The blister having risen, it should be cut round and treated with sabine ointment. The object in view is to lessen the tumefaction of the appendix.

There is little doubt, I think, that appendicitis is much commoner than it used

to be. In going over St. Bartholomew's Hospital Reports of twenty-five years ago, I noticed more than one year in which there was no admission of a case of perityphlitis or typhlitis. Is there any fresh factor in our civilisation to account for this? I believe there are two relatively recent causes—massage and the physiological exercises for the obese. Massage is largely used in the treatment of constipation, and in this condition the cæcum is likely to be full. If the object were to force some of the contents of the cæcum into the appendix, nothing would be more likely to accomplish it than deep kneading over a full cæcum. This form of massage should begin at the hepatic flexure. It is very valuable over the transverse colon as it expels that flatus, the excess of which has been shown to inhibit syphonage. Exercises for the obese, such as touching the toes with the finger-tips, are commonly practised whilst dressing in the morning—again, just when the cæcum is likely to be full. The same tendency to distend the

appendix by pressure upon the cæcum takes place when straining at stool before the motion has entered the rectum. The effect of back-syphonage upon the distension of the appendix has already been dealt with ; the two great removable causes of it being deferred defæcation and driving gas back into the sigmoid instead of retiring and expelling it. All these cautions should be borne in mind and acted upon, especially by those who have had one attack of appendicitis and do not want another.

In conclusion, it should be observed and duly pondered upon that those very peculiarities of structure and arrangement which differentiate the large from the small intestine are, on the one hand, obstacles to peristalsis and, on the other, necessary or favourable to syphonic or hydraulic action. The sudden increase of size, the greater fixity, the pioid course, the presence of saccules and ridges and their relation to their lateral neighbours, the arrangement of the longitudinal fibres in bands, and, lastly, the non-annular

character of the so-called circular fibres one and all exemplify this. Such evidence is surely irresistible.

"There is nothing new under the sun," but it is curious to find that such comparatively modern discoveries as hydraulic power, syphonic action and the Torricellian vacuum were anticipated thousands and thousands of years ago in the bodies of our ancestors, and that we are all walking about with examples of them. The point deserves to be the subject of an additional chapter in Paley!

But, useful as the applications of the view here advanced are likely to be to Medicine, it is probable that, in the remote past, syphonage had a far wider range of importance. When man gave up the arboreal habits of his progenitors, he lost much of the benefit of strong abdominal muscles, and when he adopted the erect position and thus specialised the functions of the hand, he lost the advantages of a horizontal colon. Had it not been for syphonage, he might have had to revert to his ancestral habits or, persisting, drop out of the struggle for existence.

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